*South Dakota Science and Technology Authority*
*Review Committee Report*

on the

Technical, Cost, Schedule, and Management Review

of the

# HOMESTAKE UNDERGROUND LABORATORY CONVERSION PLAN

December 2004

# EXECUTIVE SUMMARY

On 3-5 December 2004 a South Dakota Science and Technology Authority (SDSTA) Review Committee reviewed the Homestake Mine Conversion Project and the SDSTA's plans to manage the Conversion Project. The Review Committee consisted of scientists and underground mining and construction experts from within and external to the Homestake Collaboration. Several of the Committee had personal experience working in Homestake. Dr. Kevin Lesko chaired the Committee. The Committee assessed the status of the Conversion Project whose prime focus is the preservation of the Homestake site for the creation of a deep, multipurpose, and comprehensive underground laboratory. The Conversion Project addresses the reopening of the facility, reestablishment of safe underground access, refurbishment and upgrade of the underground conveyances, re-establishment of underground and surface utilities and infrastructure (including life safety), dewatering the facility, and commissioning the facility. The SDSTA correctly identifies that in the preservation of the site, a shallower, but significant underground science program would be possible. The SDSTA includes in the Conversion Project the identification of existing space for an initial suite of experiments and uses. The Conversion Project could provide beneficial underground space in the near future to the earth science, engineering and the physics communities and partially fulfill a near-term need in the United States underground science program.

- The plan for Conversion Project is advanced and comprehensive. The steps to regain beneficial occupancy underground and to deal with the water are well understood, estimated and scheduled. Several items in the Conversion Project will require careful attention as the project progresses, as these could not be evaluated from first-hand inspection. These include the shaft and ramp status and the quality of the water from the facility. No showstoppers for the Conversion Project are identified.

- To advance from the feasibility study to the final detailed engineering and construction phase the SDSTA recognizes the need to augment their organization and capabilities. Several key positions in management are indicated including EH&S, project, construction and contract management. An integrated project schedule with appropriate milestones should be developed, factoring in preparation for the Conversion Project, obtaining site title, project construction and scientific planning and operation. We note, in particular, that title to the site needs to be obtained in a timely fashion in order for the Project not to suffer significantly increased costs and schedule delays.

- A variety of options for obtaining access were evaluated. There is strong consensus that the Conversion Project should initially focus on developing access to the 4850-foot level and above.

Access to these levels will facilitate a more thorough evaluation of deeper sections of the facility. Beneficial occupancy to the levels at and above 4850-foot level will enable a strong program of earth science, engineering, physics research and education outreach to begin on a timescale for which there exist no comparable sites, thus potentially fulfilling a critical mission for the U.S. science program.

- There exists an equally strong consensus that the Conversion Project should expeditiously address the flooding of the mine and at least halt the advance of water at its level in the facility when access is gained and before the utility of the 4850-foot level is compromised. Securing title to the site should be the SDSTA's first priority, closely followed by addressing the problems posed by the flooding of the site. To reduce the overall project costs and risks to the schedule and infrastructure, the 4850-foot level must be secured and the pumping of the lower levels begun in the near future. The loss of the 4850-foot level would require a more complicated Conversion Project, increased costs, schedule delays and increased risks for degrading underground infrastructure.

- It is appropriate to begin planning in the near future for the integration of science, construction and operation of the facility at the 4850-foot level and establishing the necessary management and oversight functions from within the Authority and from the scientific community. The SDSTA is encouraged to maintain its strong ties with the scientific community to ensure that the appropriate infrastructure and capabilities are available in the facility.

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# 1. INTRODUCTION

On December 3-5, 2004 a South Dakota Science and Technology Authority (SDSTA) Review Committee conducted a review of the **Homestake Mine Re-entry and Conversion Project** at Dynatec Headquarters in Richmond Hill, Ontario, Canada. The Conversion Project is the first phase of the conversion the Homestake Gold Mine, in Lead South Dakota, into a deep multipurpose facility to pursue underground science, engineering and outreach. The SDSTA Conversion Project addresses: the reopening of the facility, reestablishment of safe underground access, refurbishment and upgrading of the underground conveyances, re-establishment of underground and surface utilities and infrastructure (including life safety), dewatering the facility, identification of existing spaces for an initial suite of experiments. In addition to the Conversion Project itself, the Committee reviewed the SDSTA's plans for commissioning the facility and providing beneficial occupancy for the earth science, engineering and physics scientific and outreach efforts. The first focus of the Conversion Project is to preserve Homestake site as a strong competitor for the NSF's Deep Underground Science and Engineering Laboratory (DUSEL). This requires expeditiously regaining access to the underground facility, securing the 4850-foot level, and halting the flooding of the deeper levels. There is significant time pressure to regain access and halt the flooding. Delaying the reentry significantly would result in the loss of additional underground infrastructure that would increase the cost of any subsequent reentry to the facility and increase the risks (both cost and schedule) for the Conversion Project. The SDSTA has correctly identified that the Conversion Project would provide beneficial occupancy to a variety of earth science, engineering, and physics programs in the near term. Consequently, attention has been paid to providing expedient access underground for this aforementioned science program and to establish a potential footing at the 4850-foot level for the possible future expansion to deeper levels and to encompass a larger underground footprint by the DUSEL process. A variety of options were presented and evaluated for obtaining safe access underground and supporting scientific endeavors. Initial concepts for a deep laboratory and requirements to gain access to deeper levels were also presented as background for the NSF process and to provide a rough estimate of the additional costs to be addressed in the NSF process for Homestake.

The mine has been closed since 10 June 2003 and with the closure has been flooding at approximately 700 gallons/min. On 10 November 2004 water sensors at 6800 feet indicated the flooding has reached this level, approximately one month behind expectations. The shafts and adits to the mine were sealed to control the underground environment and maintain infrastructure.

The Committee assessed 1) the status of the design of the Conversion Project and its suitability for near-term science projects, 2) the cost estimate, associated schedule and contingency assessment, 3) the near-term management plans for the Conversion Project, and 4) planning for the environmental, safety, and health (EH&S) aspects of the Conversion Project.

The Homestake conversion design, cost estimate and schedule are obtained from the Dynatec Corporation's study <u>Feasibility Evaluation of the Conversion of the Homestake Underground Mine to the Homestake Underground Laboratory</u> of 1 December 2004 contracted by the South Dakota Science and Technology Authority. The study was presented by Syd DeVries, John Marrington, and Tom Rannelli of Dynatec. The study includes additional work subcontracted by Dynatec detailing 1) underground ventilation, air heating and cooling and 2) electrical power, controls and communication.

The discussion of the construction management plans was led by David Snyder, Executive Director of the SDSTA, Bill Noordermeer from the Office of the State Engineer, South Dakota, and Dr. Richard Gowen of the SDSTA.

Dr. Gowen presented the environmental summary report for the Conversion Project. This summary includes reports of discussions with State Regulatory Agencies for water and waste rock permitting.

The discussion of safety plans was lead by Bill Noordermeer and included significant components from the Dynatec study. These discussions drew heavily on Dynatec's mining expertise and benefited from the Committee's experience with underground construction and science. Dynatec, founded in 1980, has completed over 1000 mining contracts. Of their three major divisions, their experiences in the Mining Services and Operations Division is the most appropriate for this project, however Dynatec also has substantial experience in Drilling Services and Metallurgical Technologies. They have an admirable safety record: in the 2003 calendar year their recorded lost-time accident frequency was just over 1 per 200,000 employee hours. Earlier years had comparable safety records.

A summary of available surface facilities and their current status was presented by Bill Noordermeer and includes components of an architectural and environmental assessment of the buildings and structures conducted by The Spitznagel Partners (TSP), an architectural firm from Lead, South Dakota.

In addition to these sources and references, reports from interviews of former Homestake employees, reports from the South Dakota Department of Environment and Natural Resources (DENR) inspections of the Homestake Facility, and official Homestake Mine Records are used to assess the status of the facility and to establish estimates of risk and maintenance requirements for the conversion of the facility. The inventory of existing components and supplies available on the site is integrated into the maintenance and Conversion Project. Many useful discussions between Homestake Mining Corporation and the SDSTA were noted.

The science roadmaps developed by the National Science Foundation S-1 process, those developed within the Homestake Collaboration tailored for Homestake, and those from earlier National Research Council studies were used to identify preliminary scientific requirements for the facility and assess the facility's suitability to support a phased scientific program. Additional information will be forthcoming from the NSF process and should be folded into the Conversion Project.

The SDSTA discussed their investigations to locate funding sources for the Conversion Project that are unassociated with the National Science Foundation process to establish DUSEL.

# 2. SCIENCE

As a gold mine, Homestake has a long, well documented and widely appreciated history around the world. Homestake's scientific history is shorter but attracted equally well-received worldwide recognition. With the closing of the mine its scientific prospects appeared to come to an end. With foresight, the State of South Dakota has presented through the SDSTA a set of options to preserve the viability of the Homestake site for participation in the DUSEL process. In addition to preserving Homestake's competitiveness, these options would begin a partial conversion of the mine to a condition suitable for some science in advance of the projected calendar for potential Federal funding of a full DUSEL. Consequently, adoption of one of these options would provide the US science community with 1) an extremely attractive site for a multipurpose deep underground laboratory to be more fully developed by the NSF process and 2) an excellent near-term opportunity for underground research and outreach for physics, earth sciences and engineering.

## 2.1. History of Neutrino Physics at Homestake

The Homestake Gold Mine played a seminal role in the birth of neutrino astronomy and astrophysics. In 1965 the world's first solar neutrino detector was installed at the 4850-foot level of the Homestake Mine. This detector, which consisted of a 370,000 liter perchloroethylene neutrino target, was the first to experimentally demonstrate that the energy emitted by the Sun resulted from nuclear fusion reactions. Importantly, the Homestake solar neutrino detector was the first to frame the Solar Neutrino Problem as a consequence of their observations. Simply stated the Solar Neutrino Problem required that either solar models were seriously incomplete or that 2/3 of the neutrinos produced by the fusion reactions in the Sun transformed by the time they reached the

Earth. This problem required nearly 35 years to finally resolve – ultimately it was discovered that the solar models were accurate and that neutrinos were much more complicated and perplexing than had been assumed.

This observation of "oscillation of neutrinos" opened a new window on fundamental physics that led to the upgrading of the Kamiokande detector in Japan to directly observe neutrinos in real-time and to the development of the Sudbury Neutrino Observatory (SNO) in Sudbury, Canada, the European Gallium experiment (GALLEX) in the Gran Sasso in Italy and the Soviet American Gallium Experiment (SAGE) detector at Baksan in Russia as well as the various long baseline accelerator to underground detector neutrino beam facilities in the US, Europe and Japan. Ultimately the Homestake Chlorine experiment led to the neutrino revolution and to the first new physics beyond the Standard Model of Particle Physics in nearly thirty years. In recognition of this singular achievement, Raymond Davis was awarded the National Medal of Science in 2001 and shared the Nobel Prize in 2002 with Professor Koshiba the spokesman for the Kamiokande experiment.

## 2.2. Physics Research at the 4850-foot Level

The conversion of the Homestake Gold Mine into a major underground laboratory will build on this history and develop Homestake, in a phased approach, which will insure that the site can effectively compete to be the premier underground laboratory in the world. We strongly endorse the SDSTA plan to regain access, halt the flooding at the lower levels and as a consequence provide beneficial scientific occupancy of the upper regions of the Homestake Laboratory in the near future.

The initial stage of this facility, the 4850-foot level and above, would be the deepest underground laboratory in the United States and the second deepest physics laboratory in the world. Only the SNO laboratory in Canada, at a depth of 6800-foot, is deeper. Further, as the Conversion Project presents, by dewatering the facility down to the 8000-foot level the site can be the deepest multipurpose laboratory in the world. Initial studies at of the rock properties at the 7400-foot level support that large cavities (dimensions ~ 100 m) can be excavated and made suitable for long-term experimentation.

In addition to preserving Homestake's viability as a potential DUSEL, the anticipated timetable for scientific use of the 4850-foot level is as early as 2006. This access to Homestake, along with the availability of a number of existing rooms at the 4850-foot level and the ease with which additional chambers can be excavated at this level, will provide better or timelier experimental conditions for the geoscience and physics experiments than may be available elsewhere.

Some examples of experiments for which early access into Homestake would be attractive:

1) Experiments that are ready for installation within the next year or two, some of which are presently negotiating with other sites for space.
2) Underground experiments that are presently operating at shallower depths in other laboratories and would benefit from a greater reduction in cosmic ray background and thus greater depth for their further development.
3) Less advanced experiments that need underground space to test or evaluate prototypes of their proposed experiments or to develop new detectors. This would include shared infrastructure such as ultra-low background counting and screening facilities.
4) Some of the other experiments now only on the drawing boards may need to store pure construction materials in a reduced cosmic ray environment.

In addition to experiments that are ready for deployment, we anticipate that there will be groups that will require modest space to carry out tests and evaluations of prototypes of future experiments. It is very desirable that space be provided for development of these future experiments.

Some experiments may find the cosmic ray flux at the 4850-foot level low enough for their needs in the immediate future. For experiments that ultimately require the much lower cosmic ray flux characteristic of the deeper locations in the Homestake Laboratory, i.e., 7400-foot level, initial operation at the 4850-foot level will permit testing and staging and allow rapid and efficient transfer to the lower level laboratory when that becomes available.

## 2.3. Earth Science and Engineering at the 4850-foot Level and Above

Many attractions of the Homestake site are called out in the findings of the 2003 EarthLab report to National Science Foundation. The site occupies a volume of several cubic kilometers in an area of crystalline rock whose ground water flow and recharge is relatively unknown but which might be used to better characterize flow in other crystalline terrains. Metamorphic rocks with lesser amounts of more recent intrusive rocks dominate Homestake geology. These rocks, ranging from 1920 my to 53 my, would provide a diverse and varied environment for geologic investigations. Studies might involve variations in stress, fracturing and other geomechanical properties. These geomechanical insights can be integrated with investigations of large-scale fluid-rock interactions to better understand this world-class gold deposit. Establishing the rock mechanics behavior of the Homestake geologic section will allow design and excavation of experimental chambers with long-term stability. The SDSTA's plan to reoccupy and convert the facility down to this level as early as 2006 permits deep geoscience experiments as soon as construction occurs.

Particularly attractive are attributes of the facility that will allow geosciences research to begin as access is established to various locations within the facility down to the 4850-foot level. These include:

1. Existing records of hydrology, geology, and geochemistry, plus the historical perspective provided by individuals previously associated with the mine activities.
2. Existing drifts in the facility that provide access to a large volume of the underground both horizontally and vertically. The symmetrical layout of some of the drifts will be useful for some experiments dealing with the deformation properties of the rock. Other drifts provide access to areas with minimum disturbance due to drilling or mining.
3. Variability in the geology within the facility. The facility provides a unique window into the cratonic crust, which makes up a major portion of the continent. Until now the edges of this crust could only be studied because of limited access along the coasts.
4. Presence of relatively easily accessed life-forms that either live at the limits of conditions suitable for life or have been isolated from the surface biosphere for extended periods of time.

Many short-term geosciences experiments can be initiated in concert with rehabilitation of the laboratory, whereas others can be initiated immediately after safe access to drifts has been established. These include:

1. Investigations of flow path delineation in heterogeneous geologic settings.
2. Determination of rock movement that occurs as part of the normal deformation of the underground facilities without additional mining.
3. Characterization (e.g., biological, chemical, and isotopic signatures) of seepage from various locations.
4. Preliminary investigations of microbial communities.

Some early characterization activities such as fracture mapping, stress measurements, and ground water chemistry will likely be expanded as access to various locations within the facility is established. Other investigations such as those looking at thermal-mechanical-hydrologic coupling would expand in scope (i.e. from less than one cubic meter to tens of cubic meters) as larger blocks of rock become available. These experiments will address a central question of how geological properties vary with scale and how they vary spatially. The experience gained from developing the early phases of these experiments would be invaluable for a potential deeper phase, which would extend the laboratory down to 8000-foot. The development of groundwater models and characterization of the stress field will also be an asset to engineering for future expansions of the facility. Sampling of bacteria by drilling into virgin rock from accessible drifts would serve as a prelude to the major geomicrobiological research anticipated during the DUSEL phase of the laboratory. The geotechnical properties of the nearby Yates member, a target host rock for large caverns, are relatively unexplored.

In developing rehabilitation/construction project plans, it would be helpful to incorporate the following points:

- Simultaneous access to some drifts will be required for activities associated with more than one experiment.
- Protocols need to be developed for sampling (i.e., water, rocks, microbes etc.), monitoring microclimates (near ventilation shafts/drifts), fracture mapping, and other characterization activities.
- Gaining access to the volume of rock including both drifts (initially) and the core material is important. Some areas will require access over extended period of time. Provisions should be made for allowing geoscientists to have access and the facility must understand that the primary work is science. Safety procedures should allow for non-conventional access (e.g. microbial sampling under non-ventilated conditions).
- Individual boreholes and excavated cavities may be used for different experiments. The integrity of boreholes and other such features should be maintained.
- Maps/plans for areas most likely to be accessible should be prepared and integrated with the GIS/Vulcan database (including core availability). These activities can be part of the S-2 proposal.
- Geoscience work at lower levels can be performed in a phased approach following establishment of the overlying physics experiments.

### 2.4. Additional Support for Science

In addition to underground access, we recommend that the SDSTA provide some limited surface support facilities, such as a University-style "student machine shop", staging and storage space for equipment preparatory to going underground in this early phase. It is also recommended that all scientists working underground should have regular refresher training to better appreciate differences between surface work and underground work and the inherent risks associated with the underground workplace.

### 2.5. Possible Future Expansion

Independent of the 4850-foot level science mission we recognize that an effort to prevent the further rise in the underground water level would demonstrate how the dewatering of the lower levels of Homestake would be carried out. This demonstration would be of great value in proving the viability the Homestake site in rapidly providing underground access to the 8000-foot level in the forthcoming NSF solicitation process. The presentation of a clear method, timetable and cost for final dewatering and upgrading of the lowest levels of the facility is important in building confidence in the wider community of scientists and funding agencies. Timely access to the 4850-foot level will be of great help in carrying this out and further expanding the scientific community's interest in an underground facility. A delay would have a large negative impact on the viability of Homestake site in the NSF's DUSEL process.

In terms of the six options presented in the Review, the consensus was that the optimized reentry plan was between "1b" and "2b". Having defined the goal of establishing the 4850-foot level and the need to address the flooding and halt the advance of the water in the mine, the SDSTA in concert with the science community should define an option that would provide an attractive mix of opportunities for science experiments appropriate to their own timelines, of the potential SDSTA funding profile and a demonstration to the scientific community that Homestake can be the site of choice for DUSEL.

The loss of this near-term moderate depth facility in the US could have a negative impact on scientific programs currently looking for sites to stage experiments or to perform prototype experiments.

# 3. COST, SCHEDULE AND CONTINGENCY

Syd DeVries presented a full cost estimate and associated schedule for the Conversion

Project. An outline of refurbishment costs for surface buildings was presented by Bill Noordermeer. This cost estimate includes the full, so-called, "2d" option – with mine dewatering to 8150-foot level and a Physics capability at the 7400-foot level with modest new caverns and comprehensive access to the facility for earth sciences and engineering including the ability to obtain very deep cores. Six additional options and associated schedules provided the framework for additional discussion. The risks and associated contingencies of these options were discussed.

The Conversion Project consists of a collection of tasks commonly employed in underground construction and mine maintenance. Thus the steps, required to re-commission conveyances, reestablish suitable ventilation and perform the necessary inspection and maintenance of the ground support, are fairly routine in the mining industry. The process of reestablishing access to the lower levels of a deep facility and dewatering a flooded mine have recent relevant precedence in the industry.

Prior to the closure of the facility, inspections of the facility were made. These records, Homestake's own mining records and maintenance history and the long documented quality of the naturally occurring water in the mine all support the conclusion that the degradation of infrastructure in the facility (ground support and other mining infrastructure) should be, at this point, predictable and within reason. In some mines exposure to ground water has resulted in significant loss of underground infrastructure (principally ground support) due to accelerated corrosion. This is not thought to be the case in Homestake. The underground water in Homestake is well documented as being non-acidic and the full encapsulation of the infrastructure under water should help preserve it due to the reduced oxygen exposure.

Conversion Project includes new or refurbished components for elements that are known to be advanced in their design life. In many cases replacement components are known to exist within the site inventory and are scheduled into the project. For example there are spare steel sets for the Ross shaft and a recent inspection of the shaft, prior to closure, estimated the maintenance requirements. The Conversion Project maintained a conservative approach on replacing components in many cases (that is assuming that more needed to be replaced) based on their assessment of the status of the underground site. It should be stressed that the final assessment of the replacements and maintenance can only be accomplished once visual inspection takes place. The tasks are assembled to optimize and reduce indirect costs associated with management and oversight. Many tasks are paralleled and scheduled in a manner to provide flexibility in adapting to unforeseen situations. The Conversion Project would benefit, now that the engineering feasibility is completed and once a particular option for re-entering Homestake is selected, with a specific and detailed risk assessment and management plan.

Several significant steps of the estimate could not benefit from a first-hand inspection of the underground site. In these cases the estimate relies on existing mine records and maintenance reports made available to the SDSTA and interviews of former employees and workers from the Homestake mine. Corroboration of multiple interviews provides some assurance of the validity of the conclusions drawn from these sources, however the final conditions will not be known until visual inspection can be accomplished. This argues for an expanded level of contingency for these items. Dynatec's long history in underground construction and excavation was clearly of assistance in assembling this information into the detailed engineering study for the SDSTA.

## 3.1. Findings

The cost and schedule are comprehensive, well organized and professional. Detailed backup was reviewed and found to be reasonable. Because of the inability to perform first hand inspections, the estimate assumptions were largely based on interviews and documentation from the Homestake Corporation. There are uncertainties with the status of ground control, the condition of electrical and mechanical systems and the underground water quality that would influence the water treatment to meet DENR requirements.

The fundamental assumptions in the costing of the Conversion Project were that access to the facility would be gained in the near future, that flooding would not have advanced too high in the mine and that the 4850-foot level would be used as an underground staging platform. If the flooding continues above the 4850-foot level, significantly higher costs would result for the underground conveyances and the replacement of much of the upper level infrastructure including the #6 winze. Access into the facility would be delayed and the schedules for all subsequent underground work negatively impacted.

While a variety of options were examined, the actual engineering for each option was not extensively optimized. Thus if the goal was to rapidly regain safe access to the facility and to hold the water at its then current level, rather than completely dewatering the facility, smaller pumps could be specified and significantly reduced operating costs would result, for example. It would be prudent to optimize the Conversion Project with the final option and timetables for the entire project in mind. The detailed risk assessment of the revised Conversion Project may suggest natural divisions of the Project into units based on results of underground inspections as access is regained.

## 3.2. Comments

**1.** No showstopper issues are identified for the Conversion Project, that is we could not identify any item that by itself or in concert with other items poses a significant risk to the successful completion of the project. However, several areas of construction risk are outstanding (including those that will be delineated by physical inspection such as the shaft conditions, the ramp system ground conditions below 4850-foot level, and water treatment requirements).

2. Changes in market conditions should be monitored and cost estimate reevaluated on a regular basis (commodity prices, escalation, skilled miner availability).
3. Comprehensive insurance costs should be factored into the cost estimate.
4. A significant delay to the start of the Conversion Project allowing the mine to flood above the 4850-foot level would have serious implications on cost and schedule for any subsequent use of the facility.

## 3.3. Recommendations

1. The Conversion Project identifies many of the risks in the project. However, an identification of risks by major category should be provided. The level of contingency needs to be reevaluated and incorporated in a risk management plan.
2. The SDSTA should consider contract mechanisms for managing and mitigating risk.
3. The SDSTA should incorporate critical decisions as milestones in the integrated schedule to facilitate management of the project and to assist in maintaining the schedule.

# 4. MANAGEMENT

## 4.1. Findings

The SDSTA has a good understanding of the Conversion Project and its requirements. Dynatec has assembled a competent engineering study for regaining access to Homestake and halting the flooding. With the upcoming transition from feasibility to detailed engineering and construction the SDSTA recognizes the need to augment their organization and capabilities. For similar projects at Department of Energy national laboratories significant commitments of dedicated staff would be expected as the Project moves towards construction.

It remains important that the SDSTA maintain close ties with the science community to ensure that the detailed design continues to optimize the science program for the facility.

## 4.2. Comments

1. A review of the SDSTA's overall schedule, including critical NSF DUSEL decisions, indicates that enhanced construction oversight and managerial effort will soon be needed to support critical path activities associated with the underground Conversion Project: In particular, there is an urgent need to identify personnel and select and define appropriate safety and environmental codes and practices.
2. If National Laboratory practices were followed for a contract of this size, a number of dedicated staff would be required. Project staffing would typically include a dedicated project manager and contract administrator, and underground safety and environmental professionals.
3. To maintain the estimated Project Schedule and Costs the SDSTA should expeditiously proceed to obtain title to the property and initiate the steps to preserve the utility of the 4850-foot level.

## 4.3. Recommendations

1. Once the specific construction option is adopted the Project Schedule should be updated and integrated. Management should continue to develop the comprehensive Project Schedule and incorporate additional milestones on the critical path. Milestones could be modeled after Department of Energy Critical Decision milestones.
2. A clear organization structure should be expediently developed by the SDSTA. The Organizational Chart should include positions such as project manager, construction manager, contract manager and safety & environment personnel. These positions should be filled in time for them to properly fulfill critical project roles.

# 5. ENVIRONMENT, HEALTH and SAFETY

## 5.1. Findings

The SDSTA clearly expressed that environmental protection, and worker health and safety were top priorities. They presented plans to create a program of excellence in environment, health and safety (EH&S). This philosophy aligns well with that of DOE and the NSF. The SDSTA established that safety and environmental attitudes should be firmly embedded into the work planning and practices so that the contractors, staff and visitors develop a “culture of safety”.

Management intends to take immediate ownership of safety and environmental responsibilities and ensure that all users understand that they are equal stakeholders in the EH&S programs.

The work and working environment will be regulated by the appropriate local, state and federal agencies and a variety of standards or regulations could apply to the different phases of the Conversion Project. The SDSTA intends to incorporate the most stringent work standards that are appropriate. The framework for the safe operation of the Conversion Project was presented and is based on successful programs in the mining industry.

Plans are being established to dispose of excavated rock and treating and disposing pumped water. Options for rock disposal both on-site (above and underground) and off-site are under consideration and permitting initiated. Discussions with DENR on water permitting have begun.

The SDSTA addressed issues related to local surface contamination. These areas will not be transferred with the Conversion Project and responsibility for mitigation remains with the Homestake Mining Company.

## 5.2. Comments

1. The committee strongly endorses the SDSTA’s commitment to EH&S. The culture of safety should be seamless, spanning contract workers, staff, scientists, and visiting student and across all phases of the project.
2. While in use as a scientific laboratory (and not as an operating mine), MSHA code and regulations may provide a good complement to OSHA for the facility.
3. To successfully integrate the EH&S program with construction, operations, and scientific endeavors requires expedient actions. Foremost of these is the creation and filling of EH&S positions in management.
4. There may be EH&S and Cost and Schedule advantages in collecting and pumping underground water at several different levels in the facility to take advantage of the differences in water temperature and other qualities. The SDSTA should consider evaluating these advantages in their Integrated Project Schedule.

## 5.3. Recommendations

1. The SDSTA should continue to assemble a complete set of DENR inspection records of the site before both and at time of mine closure with special emphasis on the property to be transferred to the Conversion Project.

2. SDSTA should document existing underground laboratories and their EH&S records and programs for consideration in developing the equivalent programs at Homestake. An examination of similar mine de-watering efforts, especially with similar features (depth, rock type, etc) may provide valuable empirical data for the evaluation of the Conversion Project and should be initiated in the near future.
3. The code of standards and practices, which will regulate the activities underground and above, should be expeditiously determined. An integrated training program to orient the workers and scientists to these standards and practices should be initiated. Special attention should be given to developing the training for students and other less experienced personnel. The DOE national laboratory integrated safety management plan could be considered as a model.
4. Methods of monitoring the ingress of surface water into the facility should be considered and techniques to further isolate the underground site from these sources evaluated.

# Appendix A. Charge to the Committee

November 22, 2004

Gentlemen,

Thank you for agreeing to participate in the mine reentry plan review. These plans and its review are critical to the State of South Dakota and to the South Dakota Science and Technology Authority. It is also essential this review take place for inclusion in our S2 response.

Various options for reentering the mine were discussed and accepted by the Collaboration at the Berkeley Meeting (August 2004). These six options presented below have been estimated by the SDSTA using Dynatec and State personnel, primarily Syd DeVries and Bill Noordermeer, under the supervision of Dick Gowen, Interim Executive Director of the SDSTA.

At this point the HC, the SDSTA, and the Governor's Office would benefit from a review of the plans and a careful vetting both of the scope of science that could be permitted by the options, the reliability of estimations, the organization that will conduct the work, the plan for the work, and the interfaces and connections between the organizations that will conduct the work and the science community that will make use of the facilities.

It has to be realized that the integration of the SDSTA's plans and the HC science program are still developing and that an interim management plan needs to be developed and implemented to ensure effective communications and that appropriate lines of authority exist. The approach for the review would be that the HC would make use of the facility, but that the SDSTA would own and operate the facility in the interim, until the NSF process would replace or redefine the roles. I would invite comment on the appropriate management structure for the interim operations of the Homestake facility to ensure optimum safe use of the facility and a management structure that would easily adapt or evolve to future NSF plans for DUSEL.

To review the science program and connections between the science program and the mine re-entry options representatives of the HC (its executive committee) will be asked to serve on the review board. To review the costs, schedule and management functions an independent panel of experts will be asked to review the plans. I would invite the "science team" to observe and participate in the "technical team" deliberations and process, and vise versa.

**Six Options defined by the Homestake collaboration**

1. Re-Entry; Safe Access for Mining Personnel; Basic shaft safety operation; rehab 4850 and access to 3950; safety/ventilation/limited access from bulkheads surface to 4850;Ventilation, water treatment, Continuing minimum pumping operation, Geosciences access in coordination with mining personnel only,

   - **a.** Hold water at 4850-foot level
   - **b.** Hold water at current level
   - **c.** Remove accumulated water
2. Re-Entry; Safe access for Mining Personnel and Research; shaft upgrade; rehab 4850 and access to 3950; safety/ventilation bulkheads surface to 4850; Ventilation, water treatment; Continuing pumping operation, Safe Access for Physics and Geosciences
   - **a.** Hold water at 4850-foot level, 4850 research and above
   - **b.** Hold water at current level, 4850 research and above
   - **c.** Remove accumulated water, deep research

**1. Science Plans and NSF S-2 Response (HC)**

This section is primarily aimed at defining the science and the science requirements for the mine and for defining the limitations on the science program by the different options. The connection between the initial plan to re-enter the mine and the NSF DUSEL efforts should be considered. Coordination, communication and authority issues between SDSTA and HC should be considered.

**1.** Do the re-entry plans enable a reasonable program of underground scientific endeavors? What are the experimental programs that could be entertained with the different options and what is a rough estimate of the timeline for these programs?
**2.** If the plans limit particular experimental programs, programs or uses, are the limitations reasonable when considering the national long range plans and funding profiles for the different fields?
**3.** Are safety and environmental issues adequately addressed by the plans?
**4.** Would the access and operational costs be reasonable for the programs?
**5.** What are the limitations on the program, initially, for experimental materials, personnel access, power, HVAC, other utilities?
**6.** Does a reasonable upgrade path then exist from these plans to a full NSF DUSEL?
**7.** Are the lines of authority and communication between the SDSTA and the HC well defined and effective?
**8.** Please present your comments or proposals on the interim management of the facility to unite the SDSTA facility with the HC.

**2. Project Organization (SDSTA) (limit discussion to SDSTA's reentry project)**

This section, in a normal DOE project, would be investigating the leadership of the project. In regards to the Homestake project, some assurance that the project would be conducted in an effective manner with assurances that the project has an excellent chance of succeeding on-schedule and on-budget is requested, but it would not require full conformance to DOE practices and protocols. Issues relating to the integration of the HC to the SDSTA should be considered.

**9.** Does the project have an effective organizational structure?
**10.** Does the project leadership style mesh with the project team?
**11.** Do you have any concerns and/or suggestions regarding project roles and

responsibilities?

**3. Project Plan (SDSTA) (limit discussion to SDSTA's reentry project)**

Similar to §3, the interest in the Project Plan is to obtain assurance that the Project has the appropriate structures in place to have a good chance of succeeding, but it would not necessarily require full conformance to DOE practices and protocols. The Project Plan should have adequate detail and be accessible by the HC to assure that their requirements are addressed. The Project Plan should clearly define scope of the project. If details are not yet defined by the science community a plan for defining these needs to be laid out.

**12.** In your estimation, is the proposed project plan an effective tool to guide the project from inception to completion?

**13.** Does the project plan include relevant portions, appropriate to the phase of project, such as the Statement of Work (SOW), Work Breakdown Structure (WBS), Project Execution Plan (PEP), Risk Management Plan, and the Budget and Schedule Estimates?
   i. Within the Statement of Work (SOW), are project requirements defined?
   ii. Within the Work Breakdown Structure (WBS), is the scope and level of detail appropriate?
   iii. Within the Project Execution Plan (PEP), is there a proposed approach for Configuration Management, Design Control, Quality Control, and Safety?
   iv. How are issues of Title, License, and Right-of-way dealt with? Is the title held clear and free of encumbrances or restrictions?
   v. In order to satisfy liability and indemnification issues, what legislature and action is required by the state of South Dakota?
   vi. Are Environmental and Safety issues adequately addressed in plan? What additional Environmental legislation or action by the State, Federal, or local officials is required? What has been accomplished to date? Under which Safety Agency jurisdiction will Homestake fall? Are actions in place to ensure compliance for the safety of the workers and the scientists?

**4. Technical Aspects (SDSTA) (limit discussion to SDSTA's reentry project)**

**14.** Does the project have a clear development plan for all the technical goals?
**15.** Does the baseline design meet the project's objectives?
**16.** Are technical tests and anticipated results stated?
**17.** Are design options analyzed against the baseline design?

**5. Cost (SDSTA) (limit discussion to SDSTA's reentry project)**

**18.** Is the Budget Estimate comprehensive and verifiable?

**6. Schedule (SDSTA) (limit discussion to SDSTA's reentry project)**

**19.** Is the Schedule Estimate comprehensive and verifiable?
**20.** Are schedule milestones clearly identified, and are the milestones frequent enough to gauge progress?
**21.** Does the schedule specify relationships, critical paths, slack paths, and resources in the appropriate phases and detail?

**7. Risk (SDSTA) (limit discussion to SDSTA's reentry project)**

**22.** Have risks been identified and managed appropriately?
**23.** While a DOE Risk Management Plan may not be appropriate, how are the risks identified and what measures are taken to reduce the impact of these risks on the costs and schedule?
**24.** Does the plan include a method for managing technical risk, budget risk, and schedule risk?
**25.** Are sources of risk prioritized based on their risk rating and is this rating method appropriate?

A tentative agenda is attached for the review process in Toronto. Thank you again for agreeing to help us with this review and I look forward to meeting with you on December 3.

Sincerely,

Dave Snyder
Executive Director

## Appendix B. Committee Membership

Dr. Kevin T. Lesko, Chair
Nuclear Science Division
Lawrence Berkeley National Laboratory

Dr. Dana Beavis
Physics Department
Brookhaven National Laboratory

Dr. Steve Kettell
Physics Department
Brookhaven National Laboratory

Prof. Ken Lande
Department of Physics and Astronomy
University of Pennsylvania

Prof. Robert Lanou
Physics Department
Brown University

Dr. Chris Laughton
Project Manager for Underground Design and Construction
Fermi National Accelerator Laboratory

Mr. Mark Laurenti
Quarry Manager (Former Homestake Mine Technical Service Superintendent)

Prof. William Roggenthen
Dean, Earth System
South Dakota School of Mines and Technology

Dr. Rohit Salve
Earth Science Division
Lawrence Berkeley National Laboratory

Prof. Herb Wang
Geology and Geophysics
University of Wisconsin

## Appendix C. Agenda

DUSEL Review Committee
Dynatec Headquarters
9555 Yonge Street, Suite 200
Richmond Hill, Ontario, Canada
Phone (905) 780 1980 Syd DeVries extension: 400
December 3-5, 2005

### Tentative Agenda

(Times are suggested; the committee can adjust as warranted)

**Friday December 3**

8:00 A.M. Welcome and Committee Introductions
Dave Snyder
8:15 A.M. Executive Session of the Review Committee
9:15 A.M. Presentation of the Plan: Syd DeVries
Bill Noordermeer
Dave Snyder
12:30 Noon Lunch
1:30 P.M. Matching Initial Science Requirements to the Rehabilitation Plan: Access, Infrastructure, Existing Space, and Expansion. Connections to the Scientific Community
5:30 P.M. Break for dinner
7:00 P.M. Resume Science Requirement Review

**Saturday December 4**

8:00 A.M. Underground Work Considerations &
Costs and Schedule for the Rehabilitation
12:00 Noon Lunch
1:00 P.M. Resume Costs and Schedule Review
2:30 P.M. Management of the Rehabilitation Plan
4:00 P.M. Safety & the Environment
5:30 P.M. Break for dinner
7:00 P.M. Resume Sessions

**Sunday December 5**

8:00 A.M. Close out and Report Writing
12:00 A.M. Adjourn
Note: Hotel accommodations at the Sheraton Parkway Toronto North,
600 Highway 7 East, Richmond Hill, Ontario. Telephone 1-800-668-0101.